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DESCRIPTION

VALVE GEAR HAVING A ROLLER/ROCKER ARM, FOUR-CYCLE ENGINE, AND MOTORCYCLE MOUNTING THEREON THE FOUR-CYCLE ENGINE

TECHNICAL FIELD

The present invention relates to a valve gear comprising rocker arms having roller bearings at contact portions thereof with valve gear cams, and an overhead cam type four-cycle engine having the valve gear. Further, the invention relates to a motorcycle mounting thereon a four-cycle engine.

BACKGROUND ART

So-called SOHC (Single Overhead Camshaft) type four-cycle engines are known, in which a single camshaft drives exhaust valves and intake valves. This type of four-cycle engine comprises an exhaust rocker arm, which transmits movements of an exhaust cam to exhaust valves, and an intake rocker arm, which transmits movements of an intake cam to intake valves.

The exhaust rocker arm and the intake rocker arm, respectively, are swingably supported on rocker shafts. The rocker shafts are arranged in parallel to each other with a camshaft therebetween. Therefore, the exhaust rocker arm is across the rocker shaft from the exhaust cam to extend toward the exhaust valves, and the intake rocker arm is across the rocker shaft from the intake cam to extend toward the intake

valves.

JP-B-07-068892 discloses a valve gear for four-cycle engines, in which roller bearings are incorporated into an exhaust rocker arm and an intake rocker arm, respectively. The roller bearings come into rolling contact with an exhaust cam and an intake cam to thereby restrict that frictional resistance, which is generated at contact portions between the exhaust rocker arm and the exhaust cam and at contact portions between the intake rocker arm and the intake cam, to a small magnitude.

In this conventional valve gear, when rotation of a camshaft causes the roller bearing of the intake rocker arm to get on a cam nose of the intake cam from a base circle thereof, the cam nose pushes up the roller bearing. Thereby, the intake rocker arm swings on a rocker shaft to push intake valves in an opening direction.

The rocker shaft, which supports the intake rocker arm, is positioned rearwardly of a center line, which passes through a center of the camshaft to extend axially of a cylinder, in a direction of rotation of the camshaft. Therefore, when the cam nose pushes up the roller bearing of the intake rocker arm, the rocker shaft, which supports the intake rocker arm, is not positioned in a direction, in which the roller bearing is pushed up.

In other words, in a process, in which the cam nose of the intake cam pushes up the roller bearing, a force exerted

on a contact portion, at which the cam nose and the roller bearing contact with each other, acts in a direction intersecting a line, which connects between a center of rotation of the roller bearing and a center of the rocker shaft. Accordingly, a force, with which the cam nose pushes up the roller bearing, acts as a force, by which the intake rocker arm is caused to swing on the rocker shaft, so that any unreasonable force will not be applied to the intake rocker arm.

On the other hand, the rocker shaft, which supports the exhaust rocker arm, is positioned forwardly of a center line, which passes through the center of the camshaft, in the direction of rotation of the camshaft. Therefore, in a process, in which the cam nose of the exhaust cam pushes up the roller bearing of the exhaust rocker arm, that rocker shaft, which supports the exhaust rocker arm, is positioned in a direction, in which the roller bearing is pushed up. Accordingly, a force exerted on a contact portion, at which the cam nose and the roller bearing contact with each other, acts along a line, which connects between a center of rotation of the roller bearing and a center of the rocker shaft.

As a result, a force, with which the cam nose pushes up the roller bearing, acts as a force, which causes the exhaust rocker shaft to buckle, so that a load being born by the exhaust rocker arm is increased.

Accordingly, it is necessary to take various measures

to enable the exhaust rocker arm to overcome a buckling load, so that there is caused a disadvantage that the exhaust rocker arm becomes heavy and large in size.

It is an object of the invention to obtain a valve gear capable of preventing a buckling load from being applied to a first rocker arm, which is supported by a first rocker shaft positioned forward in a direction of rotation of a camshaft, in a process, in which a cam nose on a cam shaft pushes up a roller bearing, and decreasing a load being born by the first rocker arm.

It is a further object of the invention to obtain a four-cycle engine having the above valve gear.

It is a still further object of the invention to obtain a motorcycle mounting thereon a four-cycle engine, which comprises the above valve gear.

DISCLOSURE OF THE INVENTION

In order to attain the above object, a valve gear according to an embodiment of the invention comprises

a camshaft having a first valve gear cam and a second valve gear cam,

first and second rocker shafts arranged in a manner to interpose therebetween the camshaft,

a first rocker arm swingably supported on the first rocker shaft and having at one end thereof a roller bearing, which

comes into rolling contact with the first valve gear cam, and

a second rocker arm swingably supported on the second rocker shaft and having at one end thereof a roller bearing, which comes into rolling contact with the second valve gear cam.

The first and second valve gear cams of the camshaft, respectively, comprise a base circle, and a cam nose projecting from the base circle, the first rocker shaft, which supports the first rocker arm, being positioned forwardly of a center line, which passes through a center of the camshaft to extend axially of a cylinder, in a direction of rotation of the camshaft, and the second rocker shaft, which supports the second rocker arm, being positioned rearwardly of the center line in the direction of rotation of the camshaft, and

when the roller bearing of the first rocker arm contacts with the base circle of the first valve gear cam, the first rocker shaft is shifted closer to the camshaft than a center of rotation of the roller bearing is.

In order to attain the above object, a four-cycle engine according to one mode of the invention comprising

a cylinder having a bore center line,

a cylinder head connected to the cylinder and having an exhaust valve and an intake valve,

a camshaft supported by the cylinder head and having a first valve gear cam and a second valve gear cam,

first and second rocker shafts arranged in a manner to interpose therebetween the camshaft,

a first rocker arm swingably supported on the first rocker shaft and having at one end thereof a roller bearing, which comes into rolling contact with the first valve gear cam, the first rocker arm acting to drive one of the exhaust valve and the intake valve, and

a second rocker arm swingably supported on the second rocker shaft and having at one end thereof a roller bearing, which comes into rolling contact with the second valve gear cam, the second rocker arm acting to drive the other of the exhaust valve and the intake valve.

The first and second valve gear cams of the camshaft, respectively, comprise a base circle, and a cam nose projecting from the base circle, the first rocker shaft, which supports the first rocker arm, being positioned forwardly of the bore center line, which passes through a center of the camshaft, in a direction of rotation of the camshaft, and the second rocker shaft, which supports the second rocker arm, being positioned rearwardly of the bore center line in the direction of rotation of the camshaft, and

when the roller bearing of the first rocker arm contacts with the base circle of the first valve gear cam, the first rocker shaft is shifted closer to the camshaft than a center of rotation of the roller bearing is.

In order to attain the above object, a motorcycle according to one mode of the invention comprising a frame, and a four-cycle engine supported on the frame.

The four-cycle engine comprises

a cylinder having a bore center line,

a cylinder head connected to the cylinder and having an exhaust valve and an intake valve,

a camshaft supported by the cylinder head and having a first valve gear cam and a second valve gear cam,

first and second rocker shafts arranged in a manner to interpose therebetween the camshaft,

a first rocker arm swingably supported on the first rocker shaft and having at one end thereof a roller bearing, which comes into rolling contact with the first valve gear cam, the first rocker arm acting to drive one of the exhaust valve and the intake valve, and

a second rocker arm swingably supported on the second rocker shaft and having at one end thereof a roller bearing, which comes into rolling contact with the second valve gear cam, the second rocker arm acting to drive the other of the exhaust valve and the intake valve.

The first and second valve gear cams of the camshaft, respectively, comprise a base circle, and a cam nose projecting from the base circle, the first rocker shaft, which supports the first rocker arm, being positioned forwardly of the bore

center line, which passes through a center of the camshaft, in a direction of rotation of the camshaft, and the second rocker arm, which supports the second rocker arm, being positioned rearwardly of the bore center line in the direction of rotation of the camshaft, and

when the roller bearing of the first rocker arm contacts with the base circle of the first valve gear cam, the first rocker shaft is shifted closer to the camshaft than a center of rotation of the roller bearing is.

With such constitution, when the camshaft rotates, the cam noses of the first and second valve gear cams push up the roller bearings of the first and second rocker arms.

Since the cam nose is moved in a direction away from the second rocker shaft in a process, in which the cam nose of the second valve gear cam pushes up the roller bearing, the second rocker shaft will not be positioned in a direction, in which the roller bearing is pushed up. Therefore, a force, with which the cam nose pushes up the roller bearing, acts as a force, by which the second rocker arm is caused to swing on the second rocker shaft.

On the other hand, when the roller bearing of the first rocker arm contacts with the base circle of the first valve gear cam, the first rocker shaft, which supports the first rocker arm, is shifted closer to the camshaft than the center of rotation of the roller bearing is. Therefore, the first rocker shaft

will not be positioned in a direction, in which the roller bearing is pushed up, in a process, in which the cam nose of the first valve gear cam pushes up the roller bearing.

Accordingly, a force exerted on a contact portion, at which the cam nose and the roller bearing contact with each other, acts in a different direction from that of a line, which connects between the roller bearing and the first rocker shaft. Therefore, the first rocker arm becomes hard to bear a buckling load.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view showing a motorcycle according to an embodiment of the invention.

Fig. 2 is a cross sectional view showing the positional relationship among a camshaft, an exhaust rocker arm, and an intake rocker arm in a four-cycle engine according to an embodiment of the invention.

Fig. 3 is a cross sectional view taken along the line F3-F3 in Fig. 2.

Fig. 4 is a plan view showing the positional relationship between the exhaust rocker arm and the intake rocker arm in a four-cycle engine according to an embodiment of the invention.

Fig. 5 is a plan view showing tappet covers according to an embodiment of the invention.

Fig. 6 is a cross sectional view showing a state, in which

a roller bearing of the exhaust rocker arm is pushed up by a cam nose of an exhaust cam, in the embodiment of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

An embodiment of the invention will be described below with reference to the drawings.

Fig. 1 shows a motorcycle 100 according to an embodiment of the invention. The motorcycle 100 comprises a frame 101. The frame 101 comprises a head pipe 102, left and right main frames 103 (only one of them being shown), and left and right rear-arm brackets 104 (only one of them being shown).

The head pipe 102 is positioned at a front end of the frame 101 to support a front wheel 106 through a front fork 105. The main frames 103 extend rearwardly of the head pipe 102 and incline downward as they go rearwardly of the head pipe 102. The main frames 103 support a fuel tank 107.

The rear-arm brackets 104 project downward from rear ends of the main frames 103. The rear-arm brackets 104 pivotally support a rear arm 108. The rear arm 108 extends rearwardly of the rear-arm brackets 104. A rear wheel 109 is supported at a rear end of the rear arm 108.

Left and right seat rails 110 (only one of them being shown) are connected to upper ends of the rear-arm brackets 104. The seat rails 110 pass above the rear wheel 109 to extend rearwardly of the rear-arm brackets 104. The seat rails 110

support a seat 111. The seat 111 is connected at its front end to the fuel tank 107.

As shown in Fig. 1, the frame 101 supports a water-cooled four-cycle single cylinder engine 1, which drives the rear wheel 109. The engine 1 is disposed below the main frames 103 and supported by the main frames 103 and the rear-arm brackets 104.

As shown in Figs. 1 and 2, the engine 1 comprises a crankcase 1a, a cylinder block 2, and a cylinder head 3. The crankcase 1a accommodates therein a crank shaft (not shown). The cylinder block 2 stands upright from an upper surface of the crankcase 1a. The cylinder block 2 comprises a cylinder 4. The cylinder 4 accommodates therein a piston 5. The piston 5 is connected through a connecting rod 6 to the crank shaft.

The cylinder head 3 is connected to an upper surface of the cylinder block 2. The cylinder head 3 comprises a recess 7 on its surface opposed to the cylinder 4. The recess 7 defines a pent roof type combustion chamber 8 between it and a top surface of the piston 5.

As shown in Figs. 2 and 4, the cylinder head 3 comprises a pair of exhaust ports 10a, 10b and a pair of intake ports 11a, 11b. The exhaust ports 10a, 10b and the intake ports 11a, 11b are opened to the combustion chamber 8 and arranged to be opposed to each other with a bore center line O1 of the cylinder 4, which passes through a center of the combustion chamber 8, therebetween.

The cylinder head 3 supports two exhaust valves 12, which open and close the exhaust ports 10a, 10b, and two intake valves 13, which open and close the intake ports 11a, 11b. Valve stems 12a of the exhaust valves 12 are arranged in parallel to each other and inclined in a direction away from the bore center line O1 as they become more distant from the combustion chamber 8. Valve stems 13a of the intake valves 13 are arranged in parallel to each other and inclined in an opposite direction to the valve stems 12a of the exhaust valves 12 relative to the bore center line O1.

The valve stems 12a of the exhaust valves 12 are shorter in total length than the valve stems 13a of the intake valves 13. Therefore, tip ends of the valve stems 12a are positioned below tip ends of the valve stems 13a.

The exhaust valves 12 are biased in a direction, in which the exhaust ports 10a, 10b are closed, by valve springs 14. Likewise, the intake valves 13 are biased in a direction, in which the intake ports 11a, 11b are closed, by valve springs 15.

As shown in Figs. 2 and 3, a valve gear chamber 16 is formed within the cylinder head 3. The valve gear chamber 16 is positioned just above the combustion chamber 8. Tip ends of the valve stems 12a of the exhaust valves 12 and tip ends of the valve stems 13a of the intake valves 13 project into the valve gear chamber 16.

The valve gear chamber 16 accommodates therein a valve gear 17 that drives the exhaust valves 12 and the intake valves 13. The valve gear 17 comprises a single camshaft 18, an exhaust rocker arm 19 as a first rocker arm, and an intake rocker arm 20 as a second rocker arm.

The camshaft 18 is supported at its one end and its other end through bearings 21 by the cylinder head 3. A center X1 of rotation of the camshaft 18 is perpendicular to the bore center line O1. One end of the camshaft 18 is positioned in the vicinity of the bore center line O1. Therefore, the camshaft 18 is offset radially of the cylinder 4 relative to the bore center line O1.

The other end of the camshaft 18 is disposed outside the valve gear chamber 16. A sprocket 22 is fixed to the other end of the camshaft 18. A cam chain 23 is stretched between the sprocket 22 and the crank shaft. According to the embodiment, the camshaft 18 rotates forward in a counterclockwise direction (a direction of rotation of the front wheel 106 when the motorcycle 100 advances) indicated by an arrow in Fig. 2.

As shown in Fig. 3, the camshaft 18 comprises an exhaust cam 25 as a first valve gear cam, and an intake cam 26 as a second valve gear cam. The exhaust cam 25 and the intake cam 26 are aligned axially of the camshaft 18. When the cylinder head 3 is viewed axially of the cylinder 4, the exhaust cam 25 and the intake cam 26 are offset axially of the camshaft

18 relative to the bore center line O1. An amount L1 of offset of the exhaust cam 25 relative to the bore center line O1 is larger than an amount L2 of offset of the intake cam 26 relative to the bore center line O1.

As shown in Fig. 2, the exhaust cam 25 comprises a base circle 27a, which maintains the exhaust valves 12 in a closed state, and a cam nose 27b, which actuates the exhaust valves 12 in a direction of opening. The cam nose 27b extends beyond the base circle 27a.

Likewise, the intake cam 26 comprises a base circle 28a, which maintains the intake valves 13 in a closed state, and a cam nose 28b, which actuates the intake valves 13 in a direction of opening. The cam nose 28b extends beyond the base circle 28a.

As shown in Figs. 3 and 6, oil jet ports 29a, 29b, respectively, are formed in the exhaust cam 25 and the intake cam 26. The oil jet port 29a is opened to an outer peripheral surface of the base circle 27a of the exhaust cam 25. The oil jet port 29b is opened to an outer peripheral surface of the base circle 28a of the intake cam 26. The oil jet ports 29a, 29b serve to supply a lubricating oil to respective parts of the valve gear 17. Therefore, the lubricating oil pressurized by an oil pump jets on a circumference of the camshaft 18 through the oil jet ports 29a, 29b.

As shown in Figs. 2 and 4, the exhaust rocker arm 19 is

swingably supported through a first rocker shaft 30 on the cylinder head 3. The first rocker shaft 30 is made in parallel to and disposed above the camshaft 18. Further, the first rocker shaft 30 is positioned forwardly of the bore center line O1, which passes through the center X1 of rotation of the camshaft 18, in a direction of rotation of the camshaft 18. In other words, the first rocker shaft 30 is positioned between the camshaft 18 and the valve stems 12a of the exhaust valves 12.

The exhaust rocker arm 19 comprises a cylindrical-shaped boss 31, a roller support 32, and a pair of push arms 33a, 33b. The boss 31 is swingably supported on the first rocker shaft 30. The boss 31 is offset on one side in an axial direction of the first rocker shaft 30 relative to the bore center line O1.

The roller support 32 is formed to bifurcate and to project toward the exhaust cam 25 from an outer peripheral surface of the boss 31. The roller support 32 rotatably supports a roller bearing 34. The roller bearing 34 is positioned at one end of the exhaust rocker arm 19 to come into rolling contact with the base circle 27a and the cam nose 27b of the exhaust cam 25. A center X2 of rotation of the roller bearing 34 is offset toward the first rocker shaft 30 relative to the bore center line O1, which passes through the center X1 of rotation of the camshaft 18.

As shown in Fig. 4, the push arms 33a, 33b project toward

the valve stems 12a of the exhaust valves 12 from the outer peripheral surface of the boss 31. The two valve stems 12a are evenly distributed with the bore center line O1 therebetween. In contrast, the boss 31 is offset on one side in the axial direction of the first rocker shaft 30 relative to the bore center line O1. Therefore, one 33a of the push arms and the other 33b of the push arms are different in length from each other. The other 33b of the push arms, which pushes the valve stem 12a disposed away from the boss 31, crosses a line A, which extends radially of the combustion chamber 8 to be perpendicular to the bore center line O1 and the camshaft 18.

Projecting ends of the push arms 33a, 33b are positioned at the other end of the exhaust rocker arm 19 and opposed to the tip ends of the valve stems 12a. Adjust screws 35, respectively, are screwed into the projecting ends of the push arms 33a, 33b. The adjust screws 35 abut against the tip ends of the valve stems 12a. Accordingly, the exhaust rocker arm 19 is across the first rocker shaft 30 from the exhaust cam 25 to extend toward the tip ends of the valve stems 12a of the exhaust valve 12.

Further, a pair of oil supply ports 36 are formed on the boss 31 of the exhaust rocker arm 19. The oil supply ports 36 receive the lubricating oil jetted from the oil jet ports 29a, 29b of the camshaft 18 to conduct the same between the boss 31 and the first rocker shaft 30. The oil supply ports 36 are

away from each other in an axial direction of the boss 31.

As shown in Figs. 2 and 4, the intake rocker arm 20 is swingably supported on the cylinder head 3 through a second rocker shaft 38. The second rocker shaft 38 is made in parallel to and dissposed above the camshaft 18.The second rocker shaft 38 is positioned rearwardly of the bore center line O1, which passes through the center X1 of rotation of the camshaft 18, in the direction of rotation of the camshaft 18. Therefore, the first rocker shaft 30 and the second rocker shaft 38 are arranged in parallel to each other with the camshaft 18 therebetween.

The intake rocker arm 20 comprises a cylindrical-shaped boss 39, a roller support 40, and a pair of push arms 41a, 41b. The boss 39 is swingably supported on the second rocker shaft 38. The boss 39 is offset on one side in an axial direction of the second rocker shaft 38 relative to the bore center line O1.

The roller support 40 is formed to bifurcate and to project toward the intake cam 26 of the camshaft 18 from an outer peripheral surface of the boss 39. The roller support 40 supports a roller bearing 42. The roller bearing 42 is positioned at one end of the intake rocker arm 20 to come into rolling contact with the base circle 28a and the cam nose 28b of the intake cam 26. A center X3 of rotation of the roller bearing 42 is offset toward the second rocker shaft 38 relative to the bore

center line O1, which passes through the center X1 of rotation of the camshaft 18.

As shown in Figs. 2 and 4, the push arms 41a, 41b project toward the valve stems 13a of the intake valves 13 from an outer peripheral surface of the boss 39. The two valve stems 13a are evenly distributed with the bore center line O1 therebetween.

In contrast, the boss 39 is offset on one side in the axial direction of the second rocker shaft 38 relative to the bore center line O1. Therefore, one 41a of the push arms and the other 41b of the push arms are different in length from each other. The other 41b of the push arms, which pushes the valve stem 13a disposed away from the boss 39, crosses the line A. Further, a spacing D1 between projecting ends of the push arms 41a, 41b is larger than a spacing D2 between the projecting ends of the push arms 33a, 33b of the exhaust rocker arm 19.

The projecting ends of the push arms 41a, 41b are positioned at the other end of the intake rocker arm 20 and opposed to the tip ends of the valve stems 13a. Adjust screws 43, respectively, are screwed into the projecting ends of the push arms 41a, 41b. The adjust screws 43 abut against the tip ends of the valve stems 13a. Accordingly, the intake rocker arm 20 is across the second rocker shaft 38 from the intake cam 26 to extend toward the tip ends of the valve stems 13a of the intake valve 13.

A pair of oil supply ports 44 are formed on the boss 39

of the intake rocker arm 20. The oil supply ports 44 receive the lubricating oil jetted from the oil jet ports 29a, 29b of the camshaft 18 to conduct the same between the boss 39 and the second rocker shaft 38. The oil supply ports 44 are disposed away from each other in an axial direction of the boss 39.

As shown in Fig. 2, when the roller bearing 34 on the exhaust rocker arm 19 contacts with the base circle 27a of the exhaust cam 25, the first rocker shaft 30, which supports the exhaust rocker arm 19, is shifted closer to the camshaft 18 along the bore center line O1 of the cylinder 4 than the center X2 of rotation of the roller bearing 34 is. In other words, a center X4 of the first rocker shaft 30 is disposed in a lower position than the center X2 of rotation of the roller bearing 34 as far as the roller bearing 34 contacts with the base circle 27a.

Based on this, an intersecting angle $\theta 1$ is set to, for example, 92° where $\theta 1$ indicates an intersecting angle between a line B1, which connects between the center X4 of the first rocker shaft 30 and the center X2 of rotation of the roller bearing 34, and a line B2, which connects between the center X1 of rotation of the camshaft 18 and the center X2 of rotation of the roller bearing 34.

When the roller bearing 42 on the intake rocker arm 20 contacts with the base circle 28a of the intake cam 26, the second rocker shaft 38, which supports the intake rocker arm

20, is shifted more distant from the camshaft 18 than the center X3 of rotation of the roller bearing 42 is. In other words, a center X5 of the second rocker shaft 38 is disposed in a higher position than the center X3 of rotation of the roller bearing 42 as far as the roller bearing 42 contacts with the base circle 28a.

Therefore, an intersecting angle $\theta 2$ is set to, for example, 76° where $\theta 2$ indicates an intersecting angle between a line C1, which connects between the center X5 of the second rocker shaft 38 and the center X3 of rotation of the roller bearing 42, and a line C2, which connects between the center X1 of rotation of the camshaft 18 and the center X3 of rotation of the roller bearing 42.

Accordingly, the intersecting angle $\theta 1$ is larger than the intersecting angle $\theta 2$ ($\theta 1 > \theta 2$).

As shown in Fig. 3, the cylinder head 3 comprises a recess 46, which caves toward the center of the combustion chamber 8. The recess 46 is positioned in opposition to the camshaft 18 with the bore center line O1 therebetween. A plug mount hole 47 is formed at a bottom of the recess 46 to be opened to the center of the combustion chamber 8. An ignition plug 48 is screwed into the plug mount hole 47. An insulating material 48a of the ignition plug 48 is positioned in the recess 46.

With such cylinder head 3, the camshaft 18 is offset radially of the cylinder 4 relative to the bore center line

O1. Therefore, a large space for formation of the recess 46 can be ensured in that portion of the cylinder head 3, which is opposed to the camshaft 18 with the bore center line O1 therebetween. As a result, the recess 46 can be made close to the bore center line O1, so that it is possible to have the ignition plug 48 standing upright relative to the combustion chamber 8.

As shown in Figs. 2 and 4, the cylinder head 3 comprises a first opening 50 and a second opening 51, which are opened to the valve gear chamber 16. The first opening 50 serves for tappet adjustment of the exhaust valves 12, and are shaped in a manner to expose abutting portions of the valve stems 12a of the exhaust valves 12 and the push arms 33a, 33b of the exhaust rocker arm 19. The first opening 50 is positioned at a front end of the cylinder head 3.

The second opening 51 serves for tappet adjustment of the intake valves 13, and are shaped in a manner to expose abutting portions of the valve stems 13a of the intake valves 13 and the push arms 41a, 41b of the intake rocker arm 20. The second opening 51 is positioned at a rear end of the cylinder head 3. The first and second openings 50, 51 have the same shape as each other.

As shown in Fig. 2, the first and second openings 50, 51, respectively, are covered by tappet covers 52. The tappet cover 52, which covers the first opening 50, and the tappet

cover 52, which covers the second opening 51, are common to each other and fixed to the cylinder head 3 in a removable manner.

The tappet covers 52 comprise an inner surface exposed to the valve gear chamber 16. First and second walls 54, 55 are formed on the inner surfaces of the tappet covers 52. The first and second walls 54, 55 project obliquely downward toward the valve gear chamber 16 so as to receive the lubricating oil jetted from the oil jet ports 29a, 29b of the camshaft 18. The first and second walls 54, 55 are aligned and spaced at intervals in a heightwise direction of the cylinder head 3, and extend axially of the first and second rocker shafts 30, 38.

As shown in Fig. 5, the first wall 54 is positioned above the second wall 55. The first wall 54 comprises a pair of V-shaped oil guides 56a, 56b. The oil guides 56a, 56b comprise supply ports 57a, 57b, which are arranged widthwise of the tappet cover 52 and have the lubricating oil, which is received by the first wall 54, dripping. A spacing D3 between the supply ports 57a, 57b corresponds to the spacing D2 between the push arms 33a, 33b of the exhaust rocker arm 19.

The second wall 55 positioned below the first wall 54 comprises a pair of V-shaped oil guides 58a, 58b. The oil guides 58a, 58b comprise supply ports 59a, 59b, which are arranged widthwise of the tappet cover 52 and have the lubricating oil, which is received by the second wall 55, dripping. A spacing D4 between the supply ports 59a, 59b corresponds to the spacing

D1 between the push arms 41a, 41b of the intake rocker arm 20.

By virtue of this, the supply ports 57a, 57b of the first wall 54 are positioned just above the projecting ends of the push arms 33a, 33b of the exhaust rocker arm 19 in a state, in which the first opening 50 on an exhaust side is covered by the tappet cover 52. Accordingly, the lubricating oil is supplied through the supply ports 57a, 57b to abutting portions of the adjust screws 35 and the valve stems 12a of the exhaust valves 12.

Likewise, the supply ports 59a, 59b of the second wall 55 are positioned just above the projecting ends of the push arms 41a, 41b of the intake rocker arm 20 in a state, in which the second opening 51 on an intake side is covered by the tappet cover 52. Accordingly, the lubricating oil is supplied through the supply ports 59a, 59b to abutting portions of the adjust screws 43 and the valve stems 13a of the intake valves 13.

Accordingly, although the first opening 50 on the exhaust side and the second opening 51 on the intake side are covered by the common tappet covers 52, it is possible to surely supply the lubricating oil to the abutting portions of the adjust screws 35 and the exhaust valves 12 and the abutting portions of the adjust screws 43 and the intake valves 13.

In particular, according to the embodiment, the boss 31 of the exhaust rocker arm 19 and the boss 39 of the intake rocker arm 20 are offset relative to the bore center line O1 axially

of the first and second rocker shafts 30, 38. Therefore, the oil jet ports 29a, 29b of the camshaft 18, from which the lubricating oil is jetted, are distant from the valve stem 12a of the other of the exhaust valves 12 and the valve stem 13a of the other of the intake valves 13. As a result, the lubricating conditions of the other of the exhaust valves 12 and the other of the intake valves 13 become strict at the time of idling operation, at which the lubricating oil is jetted in small amount.

With the above constitution, the lubricating oil can be supplied to the abutting portions of the adjust screws 35 and the other of the exhaust valves 12 and the abutting portions of the adjust screws 43 and the other of the intake valves 13 from the supply ports 57a, 57b, 59a, 59b formed on the tappet covers 52. Therefore, even when the abutting portions are distant from the oil jet ports 29a, 29b, the lubricating oil being supplied to the abutting portions will not be made short. Accordingly, reliability in lubrication is improved.

Subsequently, an operation of the valve gear 17 will be described with reference to Fig. 6.

Fig. 2 shows a state, in which the roller bearing 34 on the exhaust rocker arm 19 and the roller bearing 42 on the intake rocker arm 20, respectively, contact with the base circle 27a of the exhaust cam 25 and the base circle 28a of the intake cam 26. At this time, the exhaust valves 12 and the intake valves

13 are closed.

When the camshaft 18 rotates forward in a counterclockwise direction indicated by the arrow in Fig. 2, the roller bearing 34 on the exhaust rocker arm 19 gets on the cam nose 27b from the base circle 27a of the exhaust cam 25. The cam nose 27b pushes up the roller bearing 34 of the exhaust rocker arm 19. Therefore, the exhaust rocker arm 19 swings on the first rocker shaft 30, and the push arms 33a, 33b of the exhaust rocker arm 19 push down the valve stems 12a of the exhaust valves 12. Accordingly, the exhaust valves 12 are opened.

Succeedingly, the roller bearing 42 on the intake rocker arm 20 gets on the cam nose 28b from the base circle 28a of the intake cam 26. The cam nose 28b pushes up the roller bearing 42 of the intake rocker arm 20. Therefore, the intake rocker arm 20 swings on the second rocker shaft 38, and the push arms 41a, 41b of the intake rocker arm 20 push down the valve stems 13a of the intake valves 13. Accordingly, the intake valves 13 are opened.

The second rocker shaft 38, which supports the intake rocker arm 20, is positioned rearwardly of the bore center line O1, which passes through the center X1 of rotation of the camshaft 18, in the direction of rotation of the camshaft 18. Therefore, the cam nose 28b of the intake cam 26 is moved in a direction away from the second rocker shaft 38 in a process, in which the cam nose 28b pushes up the roller bearing 42.

Accordingly, the second rocker shaft 38 will not be positioned in a direction, in which the roller bearing 42 is pushed up. As a result, a force, with which the cam nose 28b pushes up the roller bearing 42, acts as a force, by which the intake rocker arm 20 is caused to swing on the second rocker shaft 38.

On the other hand, the first rocker shaft 30, which supports the exhaust rocker arm 19, is positioned forwardly of the bore center line O1, which passes through the center X1 of rotation of the camshaft 18, in the direction of rotation of the camshaft 18. The first rocker shaft 30 is disposed in a lower position than the center X2 of rotation of the roller bearing 34 when the roller bearing 34 of the exhaust rocker arm 19 contacts with the base circle 27a of the exhaust cam 25.

By virtue of this, the first rocker shaft 30 will not be positioned in a direction, in which the roller bearing 34 is pushed up, in a process, in which the cam nose 27b of the exhaust cam 25 pushes up the roller bearing 34. Accordingly, a force F exerted on a contact portion, at which the cam nose 27b and the roller bearing 34 contact with each other, acts in a different direction from that of the line B1, which connects between the center X2 of rotation of the roller bearing 34 and the center X4 of the first rocker shaft 30, as shown by an arrow in fig. 6.

In other words, the valve gear 17 prescribes the

relationship of relative positions of the center X4 of the first rocker shaft 30, the center X2 of rotation of the roller bearing 34 of the exhaust rocker arm 19, and the center X1 of rotation of the camshaft 18 such that the exhaust rocker arm 19 does not buckle when the exhaust rocker arm 19 swings in a direction, in which the exhaust valves 12 is opened.

As a result, although the first rocker shaft 30 is positioned forwardly of the bore center line O1 in the direction of rotation of the camshaft 18, the exhaust rocker arm 19 becomes hard to bear a buckling load. Therefore, it is possible to decrease a load being born by the exhaust rocker arm 19, so that it is not necessary to take measures of large-scaled reinforcement to enable the exhaust rocker arm 19 to withstand a buckling load. Accordingly, the exhaust rocker arm 19 can be formed to be lightweight and compact.

Further, with the above constitution, most of a force, with which the cam nose 27b pushes up the roller bearing 34, can be made effective use of as a force that swings the exhaust rocker arm 19. Thereby, the exhaust rocker arm 19 swings smoothly. Accordingly, it is possible to make the exhaust rocker arm 19 lightweight and to reasonably cope with high-speed rotation of the engine 1.

In addition, since the first rocker shaft 30 is positioned to be lower than the camshaft 18, the upper surface of the cylinder head 3 can be lowered in position. Accordingly, there is produced

an advantage of contributions to compactness of the cylinder head 3.

The invention is not limited to the above embodiments but can be carried out in various modifications within the scope not departing from the gist of the invention.

While the above embodiments are directed to a so-called four-valve engine, in which a pair of exhaust valves and a pair of intake valves are provided in one combustion chamber, the invention is not limited thereto. The invention can be carried out in, for example, a two-valve engine, in which one exhaust valve and one intake valve are provided in one combustion chamber, or likewise in a three-valve engine, in which one exhaust valve and a pair of intake valves are provided in one combustion chamber.

In addition, the rocker arm supported by the first rocker shaft, which is positioned forward in the direction of rotation of the camshaft, is not limited to one that drives the exhaust valves but may be one that drives the intake valves.

Further, there is no need of arranging the camshaft on the bore center line. For example, the camshaft may be offset toward the exhaust valves or the intake valves relative to the bore center line.

INDUSTRIAL APPLICABILITY

According to the invention, the first rocker arm becomes

hard to bear a buckling load, so that it is possible to decrease a load being born by the first rocker arm. Accordingly, it is not necessary to take measures of large-scaled reinforcement to enable the first rocker arm to withstand a buckling load, so that the first rocker arm can be made small-sized and lightweight.